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INNOVATION

Medical Imaging: NASA's New Initiative

NASA Researchers Improve Videos
Searching the Eyes for Answers
Making X-Rays Better

NASA

Aerospace Technology
INNOVATION
Volume 10, Number 1 January/February 2002

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NASA is launching a medical imaging initiative to promote partnership and commercialization of NASA technologies in the medical imaging industry.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date	Flight	Payload	Sponsor/Coordinator
3/02	ISS Flight 8A	Zeolite Crystal Growth (ZCG)	Center for Advanced Microgravity
		Commercial Generic Bioprocessing Apperatus (CGBA)	BioServe Space Technologies
		Commercial Protein Crystal Growth (CPCG)	Center for Biophysical Sciences and Engineering

ISS—International Space Station

WELCOME TO INNOVATION

NASA Embarks on a New Initiative: Medical Imaging

By Nona Cheeks
TCO Manager, Commercial Integration & Program Operations
Technology Commercialization Office
NASA Goddard Space Flight Center

WHETHER FINDING NEW APPLICATIONS FOR existing NASA technologies or developing unique marketing strategies to demonstrate them, NASA's offices are committed to identifying unique partnering opportunities. Through their efforts, NASA leverages resources through joint research and development, and gains new insight into the core areas relevant to all NASA field centers. One of the most satisfying aspects of my job comes when I learn of a mission-driven technology that can be spun-off to touch the lives of everyday people. NASA's New Partnerships in Medical Diagnostic Imaging is one such initiative. Not only does it promise to provide greater dividends for the country's investment in aerospace research, but also to enhance the American quality of life.

MANY OF THE OPPORTUNITIES FOR JOINT DEVELOPMENT AND TECHNOLOGY TRANSFER TO THE MEDICAL IMAGING MARKET ALSO HOLD THE PROMISE FOR FUTURE SPIN BACK TO NASA.

This issue of *Innovation* highlights the new NASA-sponsored initiative in medical imaging. Early in 2001, NASA announced the launch of the New Partnerships in Medical Diagnostic Imaging initiative to promote the partnership and commercialization of NASA technologies in the medical imaging industry. NASA and the medical imaging industry share a number of crosscutting technologies in areas such as high-performance detectors and image-processing tools. Many of the opportunities for joint development and technology transfer to the medical imaging market also hold the promise for future spin back to NASA.

NASA Goddard Space Flight Center (GSFC) leads this new NASA initiative. For the past 30 years, NASA GSFC has been committed to finding innovative secondary applications for its technologies in the health industry. Some of the center's most significant spin-offs were technologies such as the Programmable Pacemaker, the Lixiscope, the Implantable and External Pumps, the Temperature Pill and the Digital-Imaging Breast Biopsy System. Goddard's interest in the medical industry continues to produce breakthrough technologies that will be featured at the SPIE Medical Imaging 2002 conference on February 23–28 in San Diego, CA, such as:

- Recursive Hierarchical Image Segmentation;
- Image Micro-Well Detectors for X- and Gamma-Ray Applications; and
- Thin-Foil Multi-Layer X-Ray Mirror Assemblies for Hard X-Ray Imaging.

Samples of the technologies that will be featured from other centers include:

- Rotational-Translational Fourier Imaging System;
- NASA Virtual GloveboX;
- Video Image Stabilization and Registration (VISAR); and
- Eye Tracker Technology.

The feature article of this issue highlights these technologies and emphasizes NASA's marketing efforts. NASA's marketing strategy in the medical imaging arena will continue to unfold with a showcase of technologies at the SPIE conference. In addition to Goddard, representatives from the following NASA centers will present briefings and demonstrate their technologies at SPIE:

- Ames Research Center
- Marshall Space Flight Center
- Jet Propulsion Laboratory

NASA's goal in the New Partnerships in Medical Diagnostic Imaging initiative is to help members of the health and medical industry become more aware of the important gains from partnerships with NASA. Our aim is to leverage the expertise of both NASA and industry partners, and to advance the agency's goal of benefiting the citizenry. This initiative represents a more proactive approach to commercialization in this field. ✱

COVER STORY

NASA's Medical Diagnostic Imaging Initiative: Promoting Partnerships in Tech Transfer and Commercialization

The New Frontier for R&D

THE UNITED STATES IS A GLOBAL LEADER IN medical technology development. As the premier US federal agency on aerospace technology, NASA has launched the New Partnerships in Medical Diagnostic Imaging initiative to identify, develop and promote partnerships and commercialization of NASA technologies in the medical imaging industry. As part of the NASA-wide technology commercialization marketing initiative, the objective is to develop opportunities for NASA to partner with companies in areas of mutual interest, such as in image detectors, image processing and image data management. The purpose is to:

- Gain insight into new projects and approaches to solve challenges in the medical industry;
- Leverage resources through cooperative development of new technology; and
- Initiate unique licensing and partnering opportunities with industry.

NASA's Goddard Space Flight Center (GSFC) leads the multi-center initiative. NASA and the medical imaging industry share a number of technology development objectives, including:

- High-performance detector materials and systems for x-ray, gamma ray, infrared, ultrasound and other modalities;
- Sophisticated image-processing tools for image classification, image segmentation, pattern recognition and image fusion; and
- High-capacity storage, high-bandwidth communication and image visualization tools for image data management.

NASA's program goals are to establish innovative technology development partnerships, to reduce company R&D investment through licensing, to improve global competition and to improve the quality of life through technological advances in order to maximize the benefit of taxpayer-funded technology.

Medical Diagnostic Imaging Workshop

NASA Goddard hosted the New Partnerships in Medical Diagnostic Imaging workshop on July 17 and 18, 2001, in Greenbelt, Maryland. The workshop was an opportunity for NASA to showcase technologies with applications in medical imaging and to introduce potential industry partners to new developments in imaging technologies. The event provided a forum for discussion on how to leverage resources and increase the involvement of industry in NASA's technology development programs to form effective and productive partnerships.

Several NASA technologies that could be used to improve some of the current challenges facing the medical imaging industry today were highlighted at the workshop. For example, the showcase of technologies featured product improvements in the areas of solid-state x-ray and gamma-ray detectors, and image-processing tools. The workshop was a great success in that the attendance far exceeded expectation and included industry leaders and representatives from large and small innovative medical imaging companies. Several technology interests and significant leads resulted from the workshop. Efforts are currently under way to follow up on funding, commercialization and partnerships.

SPIE—Medical Imaging 2002

As NASA continues its journey in the exploration of joint development opportunities in medical imaging, the agency continues to seek out forums with prospective partners in the field by participating in nationally held events such as the Medical Imaging 2002 conference sponsored by SPIE—The International Society for Optical Engineering, which will be held in San Diego, California, February 23–28. The meeting will feature presentations on the most up-to-date research and development. For more details on the conference, go to the SPIE Web site at *www.spie.org/conferences*

In conjunction with SPIE's Medical Imaging 2002 conference, NASA will present a workshop on current technologies in the areas of novel image detectors, image processing and image data management. NASA will have technical exhibits to demonstrate emerging technologies. NASA technolo-

gists will highlight ongoing technology developments in x-ray and gamma-ray imaging systems, 3-D visualization, sophisticated data mining tools and other areas. Some of NASA's featured technologies will include:

Goddard Space Flight Center

1. Recursive Hierarchical Image Segmentation

Many medical imaging applications require high-quality analysis of segmented imagery data. The quality of segmented data analysis is highly dependent on the quality of the underlying image segmentation. The high quality of the HSEG and RHSEG segmentations and the flexibility of the segmentation hierarchy output would significantly improve current analyses of segmented imagery data for many medical imaging applications.

2. Imaging Micro-Well Detectors for X- and Gamma-Ray Applications

Gas proportional counter arrays based on the micro-well are an example of a new generation of detectors that exploit narrow anode-cathode gaps, rather than fine anodes, to create gas gain. These are pixelized and, therefore, inherently imaging detectors that can be made very large at reasonable costs. Because of their intrinsic gain and room-temperature operation, these detectors can be instrumented at a very low-power-per-unit area, making them valuable for a variety of space flight applications where large-area x-ray imaging or particle tracking is required.

NASA Goddard has developed a fabrication technique using a masked UV laser that allows the user both to machine micro-wells in polymer substrates and to pattern metal electrodes. This technique has been used to fabricate detectors that image x-rays by simultaneously reading out orthogonal anode and cathode strips.

3. Thin Foil Multilayer X-Ray Mirror Assemblies for Hard X-Ray Imaging

Thin foil-replicated x-ray optics have been used successfully in field x-ray astronomy for over a decade to provide arc minute-scale angular resolution images, but only recently has the energy band been pushed above 10 keV. The International Focusing Optics Collaboration for m-Crab Sensitivity (InFOCmS) hard x-ray telescope was completed recently and is awaiting launch on a balloon payload to observe astronomical sources in the 20- to 40-keV band. InFOCmS will be the first demonstration of a multilayer-based hard x-ray telescope used for astronomical imaging. The x-ray mirror assembly is a conical approximation Wolter I design, with 255 nested cones. Each foil in the assembly is coated with a depth graded Pt/C multilayer to provide acceptable reflectivity at high energies and viable grazing angles. The imaging performance and limitations of this type of mirror will be presented.

NASA Goddard also has been working on a dedicated medical imaging device that should yield the same divergent beam to which radiologists are accustomed while removing undesirable x-ray wavelengths. A prototype of the thin-film multi-layer x-ray narrow-band filter/monochromator has been designed to produce fan-shaped beams of x-rays at 33 keV. A set of closely spaced thin-foil substrates coated with laterally graded Pt/C multilayers provides energy selectivity when illuminated by a (diverging) broadband x-ray beam incident on the foils at near-grazing angles from 0.2° to 0.3°. The individual thin foil mirrors are mounted into top and bottom precision alignment structures formed by deep reaction, ion etching and 1-mm-thick silicon wafers.

Ames Research Center

1. NASA Virtual GloveboX (VGX): Advanced Astronaut Training and Simulation System for Life Science Experiments Aboard the International Space Station

The International Space Station will soon provide an orbiting research facility for addressing fundamental questions on the long-term effects of microgravity on living systems. Many of these life science experiments will require the use of the Space Station Glovebox Facility—a contained reach-in environment where astronauts will handle animals and other organisms, perform experimental assays and collect biological samples. To aid in this endeavor, virtual environment technologies are being developed at NASA Ames Research Center to assist astronauts in training and performing complex experiments in the Space Station Glovebox. This "Virtual GloveboX" (VGX) is designed to integrate ultra-high-resolution imaging technology and force-feedback devices with high-fidelity graphics and real-time computer simulation engines to provide a realistic immersive environment. In the future, this system may be used

on Earth by astronauts to conduct experiments in a simulated real-time microgravity environment. In addition, the VGX software and simulation environment may be taken aboard the Space Station, allowing astronauts to rehearse established procedures or practice novel protocols prior to performing actual experiments or tasks.

Marshall Space Flight Center

1. Rotational-Translational Fourier Imaging System and High-Precision Grids for Neutron, Hard X-Ray and Gamma-Ray Fourier Imaging Systems

NASA scientists have discovered a method for providing Fourier Imaging with as few as one or two grid pairs while capturing the entire available spectrum. The result is an imager that costs less to produce and offers high-quality imaging. In the past, multiple grid pairs have been needed to create a Fourier telescope. It had been theorized that one or two grid pair telescopes were feasible, but this MSFC invention, the Rotational-Translational Fourier Imaging System, has overcome the multiple grid pair hurdle, creating an imaging system that uses only two grid pairs. The first grid pair offers multiple real components of the Fourier-based image. The second grid pair provides multiple imaginary components of the Fourier-based image.

With the reduction in grid pairs, the cost of producing the multiple grid pairs has been lowered. In fact, depending upon the application, the two grid pair production costs can be one tenth of the price of a comparable 24-grid pair imager. While one would expect the quality of the invention's spectrum analysis to decline with the reduction in grid pairs, the opposite is actually the case. In fact, the Rotational-Translational Fourier Imaging System provides the ability to capture images across the entire available spectrum.

Although the technology was developed for telescopes, its strength is full-spectrum imaging of atomic particles and electromagnetic radiation.

2. VISAR Video Image Stabilization and Registration

VISAR is a video image process. Supported by high-speed electronics, it could allow for real-time image stabilization in custom applications. A video-processing algorithm is used to co-align video image fields by removing the effects of translation, magnification and rotation. Because VISAR allows the user to combine several video images together, noise can be averaged out among frames. VISAR can correct image jitter to about 1/10th of a pixel. Potential applications include microscopes tracking cell or crystal activity, and medical and scientific imaging.

Jet Propulsion Laboratory

1. Eye Tracker Technology

The Experimental Science Group at JPL recently reduced both the weight and volume of an eye tracking system by six times. This miniaturization has enabled portability and improved energy efficiency by a factor of four. Healthcare-driven advanced eye tracking technology development goals at JPL include:

A) Improving the localization of brain area in relation to eye function by a factor of 10 through gaze-point tracking technical enhancements for patients undergoing functional Magnetic Resonance Imaging (fMRI0);
B) Expanding the eye tracking system to permit independent two-eye gaze-point tracking for diagnostic applications; and
C) Converting the eye tracking system to an all-digital implementation to allow further miniaturization of the equipment.

Advanced gaze-point tracking systems utilize an imaging device (CCD camera), a dynamic scene source (computer monitor, projection screen, etc.), an infrared illuminator and video processing circuits. In the simplest case, the subject views a scene on the display while the face is illuminated by an IRED. The camera acquires an image of the eye area of the face, and video-processing software detects the coroneal reflex (first-surface reflection on the illuminator) and derives the centroid of the reflection of the illumination from the retina. By determining the angle between these points, the gaze-point vector is obtained. As the gaze scans various points in the scene displayed, this gaze point is tracked. The information derived from this process includes dwell time at individual locations within a scene and the rate at which the subject scans the picture or moves their gaze from point to point. These data can then be used to determine the degree of interest that various aspects of the scene have for a specific viewer. Reduced performance can be detected as a function of physical and mental fatigue. ✱

For more information on NASA's New Partnerships in Medical Diagnostic Imaging initiative, please visit our Web site at *www.nasamedicalimaging.com*

NASA Researchers Improve Videos

TWO NASA RESEARCHERS, USING EXPERTISE and equipment normally utilized for analyzing satellite video, created technology that can dramatically improve video, including medical images and crime scene footage.

Dr. David Hathaway, a solar physicist, and Paul Meyer, an atmospheric scientist, at NASA's Marshall Space Flight Center in Huntsville, Alabama, first helped the FBI analyze video of the bombing at the 1996 Olympic Summer Games in Atlanta. Hathaway and Meyer successfully clarified nighttime videotapes made with handheld camcorders, revealing important details about the bomb and the explosion. Now this technology is being commercialized for use in home video cameras, computers and medical imaging devices.

The Video Image Registration and Stabilization (VISAR) system is used to improve the quality of video images. In the past, video stabilization has been limited to registering horizontal and vertical image movements. These methods do not account for rotational or zooming effects in video data sequences, and are sensitive to the effects of parallax when items in the background and foreground move at different rates and/or directions. VISAR can correct images when these adverse effects are present.

VISAR also eliminates other video flaws. Jagged edges found in still images extracted from video can be smoothed, and "snow" caused by video noise is reduced by adding several registered images together. De-blurring techniques offer additional improvements.

The technology is not only beneficial to existing hardware systems, but to the medical community as well. The inventors of VISAR are working with the Casey Eye Institute at the Oregon Health Sciences University in Portland through a NASA Space Act Agreement. Scientists at the institute are interested in using VISAR to enhance an innovative technique to study video of cell movements in the eye associated with immune diseases.

Additional potential applications include clarifying cell images viewed through a microscope, stabilizing eye images for retinal study, stabilizing thermal infrared imaging, stabilizing camera and body movement during endoscopic surgery and improving ultrasounds. The VISAR system can potentially be used to correct for body movement when viewing magnetic resonance imaging (MRI) videos or stabilizing images transmitted for telemedicine. ✱

For more information, contact Sammy Nabors, MSFC Technology Transfer, 256/544-5226. Please mention you read about it in *Spinoff*.

VISAR technology, which is rooted in satellite analysis, offers a range of medical imaging applications. Photos courtesy of Marshall Space Flight Center

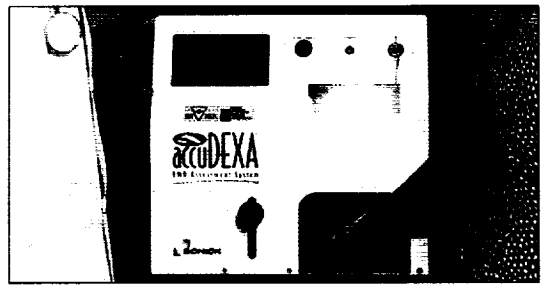
APS Meet Imaging Industry Needs

SMALLER, FASTER, CHEAPER WORKS WELL for industry, where Active Pixel Sensors (APS) have already found uses in the automotive and medical fields.

These imaging sensors require a fraction of the power and are smaller than comparable technology, making them ideal for meeting the NASA goal of providing future space missions with lighter weight and lower powered instruments. The low power needs of APS allow physicians to track the onset of osteoporosis or perform dental radiography using up to 90 percent less radiation exposure to the patient than conventional x-rays. Schick Technologies of Long Island City, New York is utilizing APS technologies to produce Computed Dental Radiography℠ (CDR).

The APS technology allows dentists using digital radiography to have all of the advantages of a digital x-ray while alleviating the disadvantages of traditional x-ray.

"The image appears on the computer screen within three seconds," said Eli Schick, director of medical products. "So instead of looking at a small dental x-ray film, you can enlarge it and utilize a number of image-enhancement features to identify problems. It also has the advantage of less exposure to radiation, not having to wait for it to be developed and not having to use harsh chemicals for developing that have to be disposed of following EPA guidelines. Images can be stored and retrieved at the click of a button."



The accuDEXA system utilizes APS technology to determine bone density loss. Photo courtesy of Schick Technologies

The company also utilizes APS technology to produce accuDEXA℠, a peripheral bone densitometer which is used to test for osteoporosis.

"There are several types of bone densitometers," Schick said. "Traditionally they assess bone density loss in the hip and the spine, and require specialized personnel to operate. Peripheral bone densitometers are easier to operate, faster and less expensive, and are designed for a primary care setting. By testing bone density at a peripheral site, such as the finger, the physician is able to determine fracture risk for the entire body. This technology offers more people the opportunity to be tested for osteoporosis, which affects 25 million Americans, about 80 percent of them women."

APS technology was developed at Jet Propulsion Laboratory. ✱

For more information, visit *http://csmt.jpl.nasa.gov/csmtpages/APS/index.html*

IMAGING DETECTS ARTERY DISEASES

The JPL Biomedical Image Processing Laboratory (BIPL), working with the University of Southern California, used ultrasound imagery, combined with computer techniques, to establish a baseline measurement to observe changes in the thickness of the carotid artery wall. Certain changes are predictors of arteriosclerosis and hypertension. Other changes, such as the effects of drug therapy, can also be measured and monitored. Carotid artery ultrasound is noninvasive and painless to the patient.

The procedure is an inexpensive way to measure the thickness of the artery, which is a highly sensitive indicator of atherosclerosis. This detection and monitoring technique can potentially prevent more costly and uncomfortable surgical procedures, and possibly save lives.

In 1992, the first methods were developed to automate the measurement of carotid wall thickness from ultrasound images. Since carotid wall thickness is a highly sensitive indicator of atherosclerosis and other arterial diseases, carotid ultrasound measurements serve a purpose similar to that of angiography in testing the efficacy of drugs and other types of therapy. Ultrasound assessment is substantially less expensive than angiography and poses no health risks to patients.

BIPL developed the first technique to assess coronary arterial narrowing by applying computer image-processing methods to coronary angiograms. In collaboration with the USC School of Medicine, these methods were used in two large-scale clinical tests of the efficacy of cholesterol-measuring drugs and currently are being used in a clinical test of estrogen-replacement therapy. ✱

For more information, visit *http://techtransfer.jpl.nasa.gov/success/success.html*. Please mention you read about it in *Innovation*.

NASA Biotechnology Project May Advance Cancer Research

ADVANCED TECHNOLOGY DEVELOPMENT projects that may hold the key to detecting cancer while it still affects only a few cells are getting under way at NASA's Ames Research Center, Moffett Field, California.

NASA Ames has awarded grants totaling $1.286 million to support 11 peer-reviewed, in-house research projects. The grants are the first step in implementing a NASA/National Cancer Institute (NCI) partnership known as Fundamental Technologies for the Development of Biomolecular Sensors. Both agencies expect program research to lead to important benefits. Ames is leading NASA's efforts in this new endeavor.

"The development of cutting-edge sensors, technologies and instruments should enable advances in biological research and human space exploration," noted John Hines, manager of the NASA Biomolecular Physics and Chemistry Program, which administers the NASA element of the collaboration. The goal of the program is to develop new molecular signatures and ways to identify molecular indications of cancer and other diseases. "This intramural research program establishes a foundation for supporting the NASA/NCI collaboration," Hines said. "We look forward to its swift execution and the validation of emerging biomolecular technologies for future NASA missions."

Research in biomolecular systems is expected to yield breakthrough technologies for minimally invasive health monitoring, early disease detection and targeted delivery of medication—benefits of interest to both organizations.

Hines noted that there is considerable overlap in the needs of NASA and NCI for biomolecular sensors. NASA needs sensors for the diagnosis and treatment of injury, illness and emerging diseases in astronauts during long-duration space flights; for monitoring and controlling life support systems; and for the remote sensing of signatures of life on distant planetary bodies. NCI needs technologies that will enable the detection of the earliest stages of cancer and provide rapid and specific treatment.

The grants will support NASA research in biosensor development, high-resolution sampling of biological specimens, a new ultra-sensitive technique for detecting organisms and their biomarkers, and detection of microorganisms on sterilized surfaces.

Awardees come from the life sciences, information technology, astrobiology and aerospace fields at Ames. The winning intramural proposals were selected from 41 received from Ames and NASA's Jet Propulsion Laboratory (JPL), Pasadena, California, which received five additional grants. Dr. Darrell Jan of JPL will serve as deputy program manager.

The development of microscopic explorers that can travel through the human body in search of disease would allow NASA to monitor astronaut health in space, where medical test capabilities and communication with Earth may be limited. New technologies also could revolutionize the speed and effectiveness of basic health care on Earth through early detection, diagnosis and treatment of cancer.

The ability to identify changes such as protein or gene expression that will develop into cancer at a later date may enable scientists to develop therapies to attack these cells before the disease spreads. "With molecular technologies, we may be able to understand the molecular signatures within a cell using the fusion of biotechnology, nanotechnology and information technology," Hines said. Ames is a leader in all three fields of research.

Currently, cancer can be detected only after it has developed into a tumor or has affected a large number of cells. Chemotherapy or radiation treatment can do significant damage to healthy cells far-removed from the cancer. If scientists can detect the disease before it affects a larger area, or even before the pre-cancerous cells become malignant, they may be able to design treatments that target only the affected cells, eliminating potential damage to other areas of the body.

Ames will focus on six key areas in molecular and cellular biology and associated technologies. Biomolecular sensors may some day be able to kill tumor cells or provide targeted delivery of medication. Molecular imaging may help scientists understand how genes are expressed and how they control cells. Developments in signal amplification could make monitoring and measurement of target molecules easier. Biosignatures—identification of signatures of life—offer the possibility of distinguishing cancerous cells from healthy cells. Information processing (bioinformatics) will use pattern recognition and modeling of biological behavior and processes to assess physiological conditions. Finally, molecular-based sensors and

instrumentation systems will provide an invaluable aid in meeting NASA and NCI objectives.

NASA is supporting the program with $10 million over five years. NCI's contribution is $10 million or more. In addition to the intramural efforts, the agencies have issued a joint extramural solicitation. Each organization will fund proposals of interest to it, with no exchange of funds between the organizations. The two agencies will jointly monitor the technical progress of all funded activities and conduct joint reviews.

NASA's participation in the collaboration is supported by the agency's Office of Biological and Physical Research, which promotes basic and applied research to support human exploration of space and to take advantage of the space environment as a laboratory. More information is available at *http://spaceresearch.nasa.gov/*

"Our goal is to really make this an applied program and to facilitate the identification and incubation of these advanced technologies, and to transfer them efficiently to NASA and NCI programs," Hines said.

More information about this program is available at *http://astrobionics.arc.nasa.gov/prob_bsrp.html* ✲

Photographic Comparisons Can Save Lives

ACCURATE SKIN MONITORING AND EARLY detection of skin cancer can save lives. Photographic techniques used to accomplish this include registration methods to precisely match the location of lesions from one visit to the next. This technology was originally developed to support the Jet Propulsion Laboratory's mission of robotic space exploration.

The JPL Biomedical Image Processing Laboratory (BIPL), working with Eye Dynamics Inc., developed a method of comparing dermatological images from a patient. These images were taken over time to monitor and track constantly changing moles that are at high risk of developing into malignant melanoma. This screening method uses sophisticated computerized registration points, optical image warping and a color-coding system that categorizes the moles photographed.

Images can be compared in a matter of minutes, while patients are still in the doctor's office. The system displays a color-coded change image that highlights moles that are new or enlarged, which appear red, and moles that have disappeared or become smaller, which appear green.

The image showing the mole changes is presented to the dermatologist, who can then re-examine the patient during the same visit to assess the changes shown. This system improves the quality of care; enhances productivity; reduces the number of doctor visits; and can cut medical costs. Early detection of pre-cancerous lesion changes is essential to successful treatment.

Skin cancer is a major concern since some 500,000 Americans a year are afflicted with the ailment. What heightens this concern is that melanoma rates have tripled in the last 40 years. Another aspect of the problem has been the detection of all-new or changed skin lesions in individuals with a condition called multiple dysplastic nevi syndrome, where there can be dozens of lesions to screen. These patients are afflicted with numerous and constantly changing moles, and are at an even higher risk of developing malignant melanoma. The large number of moles makes it very difficult for dermatologists to detect all changes, even when using high-quality traditional photographs.

The JPL Biomedical Image Processing Laboratory was established in the early 1970s, with research efforts emphasizing the development of image-processing systems and methods to solve problems in automated microscopy. Highly successful systems were developed to karyotype chromosomes, measure muscle fiber size from biopsy specimens and automate PAP smear analysis for cervical cancer detection. ✲

For more information, visit *http://techtransfer.jpl.nasa.gov/success/success.html*
Please mention you read about it in *Innovation*.

Searching the Eyes for Answers

AS A RESULT OF DR. RAFAT ANSARI'S MICROgravity research work at NASA Glenn Research Center concerning the long-term effects of space exploration on astronauts, eyes may soon yield diagnoses of a wide range of diseases long before the symptoms appear.

The research has advanced the development of ophthalmic instruments used to detect early signs of eye

diseases such as uveitis (eye inflammation), cataracts, diabetic retinopathy and age-related macular degeneration (AMD). The instruments could possibly be used to detect Alzheimer's disease as well. Manual B. Datiles, III, at the National Eye Institute (NEI) of the National Institutes of Health (NIH), has completed the first phase of clinical testing for detecting cataracts using the advancement. It is also being used to evaluate corneal abnormalities before and after popular corneal surgeries known as laser in situ keratomileusis (LASIK).

The technique deals with the characterization of proteins under microgravity conditions in outer space—proteins in the eye that ultimately lead to disease. The microgravity research that led to this discovery employs dynamic light scattering (DLS) principles. These DLS techniques can characterize protein solutions and crystallization processes in various types of fluids while aboard the space shuttle. This effort led to the production of a new miniaturized imaging probe.

The DLS probe does not require zero-gravity conditions to work and can be used to detect cataracts earlier than the techniques currently in use. By identifying eye problems at the molecular level, the probe can detect the early onset of eye diseases such as diabetic retinopathy and radiation damage. Blood sugar and cholesterol levels also can be monitored without taking blood samples.

Cataracts, AMD and Alzheimer's disease primarily affect people throughout the world over the age of 60. Cataracts are the gradual formation of protein clumps that eventually cloud the lens of the eye. Protein deposits called amyloids are present in the brains of people with Alzheimer's disease. With the adaptation of DLS techniques, physicians will be able to look into the lens, cornea, aqueous, retina and vitreous of an eye for amyloid protein. Alzheimer's disease is currently identified by examining brain tissue for amyloid proteins during autopsy. Detecting the disease in early stages may lead to treatment with anti-inflammatories, anti-oxidants or hormone replacement therapies. The possibility of early detection is unmatched by any other clinical technique currently being used. ✲

"Space Vision" goggles developed by Dr. Rafat Ansari could be used by doctors to remotely monitor the health of the eyes. Photo provided by Glenn Research Center.

For more information, contact Rafat R. Ansari, PhD, at NASA Glenn Research Center, ✆ 216/433-5008, ✉ *Rafat.R.Ansari@grc.nasa.gov*. Please mention you read about it in *Innovation*.

SHEDDING LIGHT ON CANCER

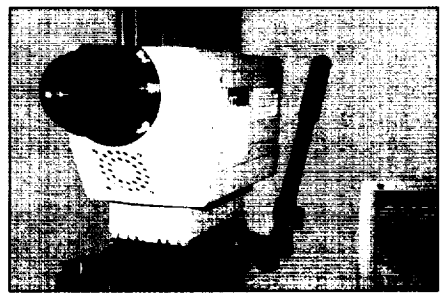
Studies have determined that cancer cells exude nitric oxide, which causes changes in blood flow in tissue surrounding cancer, that can be detected by an advanced sensor developed at NASA's Jet Propulsion Laboratory.

The BioScan System™ was developed by OmniCorder Technologies, Inc., of Stony Brook, New York. The system has been cleared to market by the Food and Drug Administration since December 1999, and has been tested by the Dana-Farber Cancer Institute of Boston, Massachusetts.

Based on a sensor called the Quantum Well Infrared Photodetector (QWIP), the BioScan System is sensitive to temperature changes of less than 0.027° Fahrenheit (0.015° Celsius) and has a speed of more than 200 frames per second. It causes no discomfort to the patient and uses no ionizing radiation. The digital sensor detects the infrared energy emitted from the body, thus "seeing" the minute differences associated with blood flow changes.

The technology has been licensed for noninvasive detection of skin cancer. Physicians are also using it during brain surgery to visualize a tumor's perimeter. The technology was inducted into the US Space Foundation Hall of Fame in 2001 in recognition of its potential uses in medicine, firefighting and industry, as well as astronomy.

"It is a great pleasure to see something we developed being used for public benefit," said Sarath Gunapala, co-inventor and principal engineer of the sensor developed at JPL, "especially in medical applications, such as the early detection of cancer." ✲

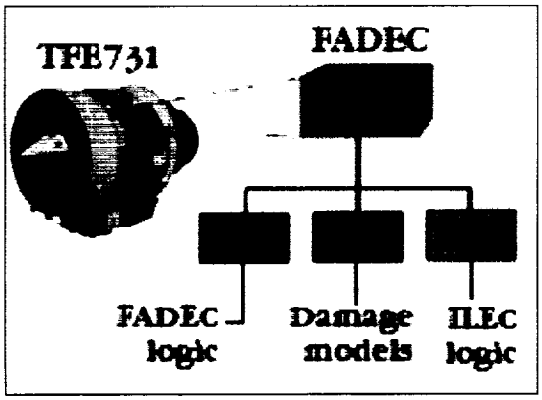


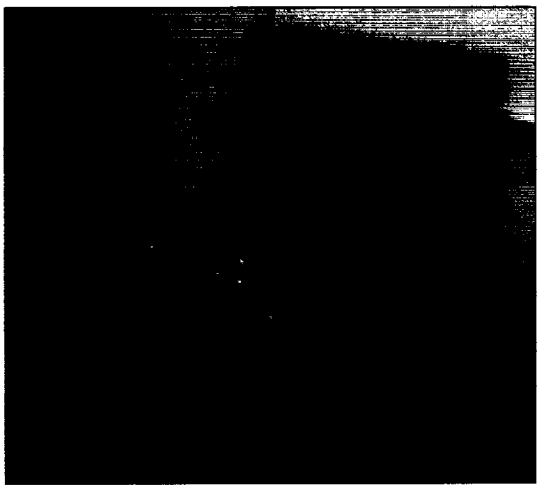
This BioScan System has been used to locate and confirm the presence of a cancerous breast lesion by detecting the cancer's ability to recruit a new blood supply—one of the hallmarks of a malignant lesion. Photo courtesy of Jet Propulsion Laboratory.

For more information, contact Surath Gunapala at Jet Propulsion Laboratory, ✆ 818/354-1880, ✉ *sarath.d.gunapala@jpl.nasa.gov*. Please mention you read about it in *Innovation*.

NASA Glenn Helps Engines Last Longer

Top: It is possible to apply ILEC technology to existing commercial turbine engines without modifying hardware or adding sensors, making it possible to retrofit existing engines by changing only the controller (FADEC) software. Bottom: A demonstration used a hardware-in-the-loop simulation to show the feasibility of integrating new ILEC logic into a flight grade commercial engine controller. Photos courtesy of Glenn Research Center.





ELECTRONIC CONTROLLERS FOR CURRENT commercial aircraft engines provide high performance and operational stability to an engine. However, the standard method of operation results in significant wear and tear on the engine, and negatively impacts the on-wing life—the time between cycles when the engine must be physically removed from the aircraft for maintenance. The resulting engine wear and damage must be monitored closely and portions of the engine regularly replaced and rebuilt in order to provide safe and reliable flight.

NASA's Glenn Research Center (GRC), along with its industrial and academic partners—Scientific Monitoring, Inc., Honeywell Aerospace, General Electric Aircraft Engines and Penn State University—has been working toward a new control concept that will include the consideration of engine damage as part of the control function. The resulting controller will be able to significantly extend the engine's on-wing life with almost no impact on engine performance and operability. The new controller design will utilize damage models to estimate and mitigate the rate and overall accumulation of damage to critical engine parts. The control methods will also provide a means for assessing trade-offs between performance and structural durability based on mission requirements and remaining engine life.

GRC originated the development of Life-Extending Control for Reusable Rocket Engines in the early 1990s. The concept was demonstrated in a simulation study with limited success due to the rigid operating envelope. These control methods, however, are now being adapted and extended to commercial turbine engine technology, where significant improvements in on-wing engine life are expected.

The IT Base Program at NASA Ames has funded Intelligent Life-Extending Control (ILEC) research since 1998 as part of its Intelligent System, Controls and Operations Project. Goals of the ILEC effort are to identify the relationships between engine performance, life usage and cost of operation for commercial engine systems; to quantify the trade-off between life usage and other parameters; and to develop and demonstrate control laws that take advantage of component life estimates to extend the on-wing engine life.

Recent efforts have been focused on applying ILEC technology to an existing commercial turbine engine, and doing so without modifying hardware or adding sensors. This approach makes it possible to retrofit existing engines with ILEC technology by changing only the controller (FADEC) software. Based on this approach, System Monitoring Inc. and Honeywell Aerospace successfully demonstrated a life-extending control at NASA Glenn in Cleveland, Ohio. The demonstration used a hardware-in-the-loop simulation to show the feasibility of integrating new ILEC logic into a flight-grade commercial engine controller.

This represented completion of a Level I milestone for the IT Base Program and paved the way for the migration of ILEC technology to an engine test phase. The significance of the demonstration includes:

- Demonstrating a 25–35 percent creep/rupture damage reduction in the engine's hot section by using smart optimization to define cruise conditions during flight. The demonstration also showed an estimated fuel savings of 2.1 percent. The trade-off is an increase in flight time of 1.3 percent.
- Demonstrating a 20–30 percent reduction in thermo-mechanical fatigue (TMF) damage to the hot section by developing and implementing smart acceleration logic during the take-off. The trade-off is an increase, from 5.0 seconds to 5.2 seconds, in the time required to reach maximum power from ground idle.
- The smart acceleration logic was successfully implemented in a flight-grade engine controller and demonstrated against Honeywell's full-envelope, real-time simulator for the Teledyne Continental TFE731-20/40/60 engine. This hardware-in-the-loop demonstration is an important step in assuring that the ILEC logic is compatible with flight-grade engine controllers.

Bob McCarty, senior principal engineer of Honeywell Engines, said that "Honeywell is very pleased with the ILEC simulations conducted in 2001. It is clear that developing the algorithms that predict engine hot-section damage, in terms of controllable parameters such as rate of change of temperature and speed, can allow new control laws that will dramatically increase engine on-wing life. We are hopeful of obtaining a go-forward program to confirm and demonstrate this technology through engine cyclic testing." ✪

For more information, contact Ten-Huei Guo at Glenn Research Center, ✆ 216/433-3734, ✉ *Ten-Huei.Guo@grc.nasa.gov*. Please mention you read about it in *Dryden Status*.

Dryden Team Increases Digital Video Capabilities

DRYDEN'S WESTERN AERONAUTICAL TEST Range (WATR) technician operations branch recently deployed a continuous 360-degree tracking pedestal featuring a high-definition (HD) digital camera and an infrared analog camera for use in the tracking of highly maneuverable experimental aircraft and space shuttles at distances of up to 100 miles, day or night. This capability is known as the HD Long-Range Optics (LRO) tower.

"This technology is very new—in fact, this capability had never been invented before. It's a little more experimental than the work we usually do in visual documentation," commented Tony Trent, WATR video systems lead, as he explained how the team took commercial off-the-shelf products and modified, integrated and tested them for use at Dryden.

A Focal Technologies fiber-optic rotary joint (FORJ)—originally produced in Nova Scotia for use in submersible, remotely operated vehicles featuring rotating manipulator arms—was modified to pass HD video and camera-control signals through two fiber-optic conductors, and to overcome the bandwidth limitation historically associated with conventional copper slip rings, Trent noted.

"Slip rings facilitate the rotation of the pedestal, but the HD system is digital, and, at 1.5 gigabits per second, it's too much for a rotating slip ring," explained Linda Peters, contractor work group lead for LRO.

The modification of the FORJ included the fabrication of a yoke assembly to enable rotation of the upper half of the FORJ with the rotation of the upper half of a pedestal (itself modified to accept the FORJ), Trent said. "The company who built the fiber joint was really amazed and impressed with our application," Trent added. "It had never been used the way we're using it."

Knight Engineering of Bloomington, California developed a design to produce a pedestal that met WATR's requirements. It took the company only three weeks to design tools and equipment to make the pedestal work.

In addition, the LRO platform was also a commercial off-the-shelf product.

"The HD camera system is the Panasonic AQ-720P prototype," said Peters. "This is a progressive HD camera that's being used in a unique application. In fact, it's the only HD camera mounted on a tracking pedestal in the world."

The HD camera was mated to a Canon zoom lens, and the entire apparatus was mounted to the tracking pedestal. The data from the camera is transmitted, with routers to recorders and displays.

The new HD LRO tower is a popular enhancement of WATR's video support of range activity and space shuttle landings because it provides HD video with unobstructed views and digital data that can be used and interfaced with computers easily.

"All of these cameras are remotely controlled," noted Peters. "Anyone who uses the range has this capability available to them and are encouraged to schedule use of these cameras for their projects."

In the few months that the new HD LRO tower has been in place, it has supported NASA, Dryden and Air Force Flight Test Center (AFFTC) programs such as three space shuttle landings, the X-38, the X-40, the X-43A, the F/A-18 Autonomous Formation Flight (AFF), the X-32 and X-35 and the F-22 Raptor—and it will be supporting the X-45 in the near future. Support of AFFTC programs is provided as part of the AFFTC/NASA Alliance.

"We tracked Atlantis's February 20 landing with the LRO," elaborated Peters. "Kennedy Space Center covers space shuttle launches with a camera that rotates 90 degrees; our LRO's capability is a continuous 360-degree view."

"We then took that footage and converted it to standard video for the networks, but it was still better quality footage than they would have otherwise received," added Trent. ✪

For more information, contact Tony Trent, Video Systems Lead, ✆ 661/276-2570. Please mention you read about it in *Dryden Status*.

Dryden Engineers Receive Emergency Flight Control Patent

ENGINEERS AT NASA'S DRYDEN FLIGHT Research Center in Edwards, California have received a patent on an emergency flight control system using only one engine and fuel transfer.

Engineers Frank Burcham, John Burken and Jeanette Le designed the software and the emergency control scheme entitled Emergency Flight Control System Using One Engine and Fuel Transfer.

The patent provides pilots with another method of landing an aircraft in emergency conditions, such as total hydraulic pressure loss and engine failure on one side. The Propulsion-Controlled Aircraft (PCA) project at Dryden in the early 1990s provided the first reliable method for dealing with such large-scale failures in flight. Results from testing the emergency control system in simulators show an increase in the chances of safely landing a crippled airplane.

"Normally, the damage that results in a total loss of the primary flight control of a transport airplane, including all the engines on one side, would be catastrophic," says John Burken. "In response to this type of failure, Dryden has conceived a fix. The emergency controller uses the engines still working, along with a lateral center-of-gravity shift from transferring fuel," Burken said.

The alternative remedy addressed by the patent provides for the control of a troubled aircraft by shifting its lateral center of gravity via fuel transfer and by coordinating the thrust of only one engine in conjunction with the fuel transfer. In transferring fuel out of the wing with the failed engine(s), the weight of that fuel added to the other wing helps balance the off-center thrust condition caused by the failed engine(s). Autonomous fuel transfer can then be used to affect the pitch and roll of an aircraft. The patent serves primarily multi-engine aircraft with multiple fuel tanks.

Emergency flight control system software programmed into an aircraft's flight control computer is linked to existing autopilot knobs in the cockpit. The software automatically commands the required fuel transfer and engine thrust variances to accommodate the pilot's inputs, while compensating for whatever caused the emergency, such as a failed engine.

This changing of an aircraft's center of gravity and thrust situation is much too complicated for a pilot, thus requiring computer control. It also frees the pilots to perform other functions during an emergency, rather than having to concentrate on transferring fuel quickly and accurately while continually adjusting the throttles of good engines.

Lateral center-of-gravity shifting in the transport airplanes studied (MD-11, C-17 and B-747) ranges from four to six feet. On the MD-11, the fuel shift moves the weight to the left or right at about three inches per minute. Wings-level flight can be maintained immediately, but approximately five to eight minutes is required to achieve level flight. The control system may provide for a survivable landing if the original control failure is not too severe and occurs at a sufficiently high altitude to allow time for the fuel shift.

Burcham, Burken and Le all participated in the previously related PCA project at Dryden, which resulted in the successful landing of MD-11 and F-15 research aircraft using only throttle control. None of the usual flight controls, such as ailerons, flaps or stabilizers, were used. ✱

For more information, contact Frank Burcham at NASA Dryden Flight Research Center, ✆ 661/276-7979, ✉ *Frank.burcham@dfrc.nasa.gov*. Please mention you read about it in *Innovation*.

NASA AIRCRAFT COMPLETE WINGTIP VORTEX STUDY

A NASA F/A-18 jet flying in the wingtip vortex behind another F/A-18 exhibited a 12-percent fuel savings at cruise altitude. The two aircraft, part of the Autonomous Formation Flight (AFF) project based at NASA's Dryden Flight Research Center in Edwards, California, flew the mission in early December.

During the 96-minute flight, the trailing aircraft burned about 600 pounds less fuel than a third F/A-18 that flew outside the formation. The savings demonstrated the aircraft range could have been extended more than 100 nautical miles while flying in formation.

The trailing F/A-18 and the solo aircraft flew a second flight to verify the fuel readings, and the results proved to be the same as the operational flight.

The goal of the Autonomous Formation Flight project is to demonstrate sustained 10-percent fuel savings of the trailing aircraft. The project seeks to extend the symbiotic relationship of migrating birds to manage formations of aircraft. The traditional "V" formation allows each bird flying aft of the lead bird to reduce drag and conserve energy.

Although fighter-type aircraft are being used for the technology demonstration, commercial or military transport aircraft, as well as uninhabited aerial vehicles, can benefit from formation flight fuel and drag reduction. ✱

For more information, contact Gerard Schkolnik at Dryden Flight Research Center, ✆ 661/276-3055, ✉ *Gerard.schkolnik@dfrc.nasa.gov* or Brent Cobleigh at Dryden Flight Research Center, ✆ 661/276-2249, ✉ *Brent.cobleigh@dfrc.nasa.gov*. Please mention you read about it in *Innovation*.

Making X-Rays Better

REVERSE GEOMETRY X-RADIOGRAPHY (RGX®) was developed by Digiray, Corp., using two NASA Small Business Innovation Research (SBIR) program awards.

Unlike conventional x-ray systems, which place the radiographic object close to the large-area detector, the Digiray system places the radiographic object close to the x-ray source. A point detector then captures the primary radiation without the image-degrading secondary radiation inherent in standard x-ray systems.

Another fundamental difference between the two radiographic processes lies in the performance characteristics of the imaging detectors. Digital images are produced by Digiray's system using a scintillating crystal with a dynamic range at least 10 times superior to film. This digital image can then be enhanced by a wide variety of standard image-processing tools such as averaging, filtering, image subtraction and edge enhancement.

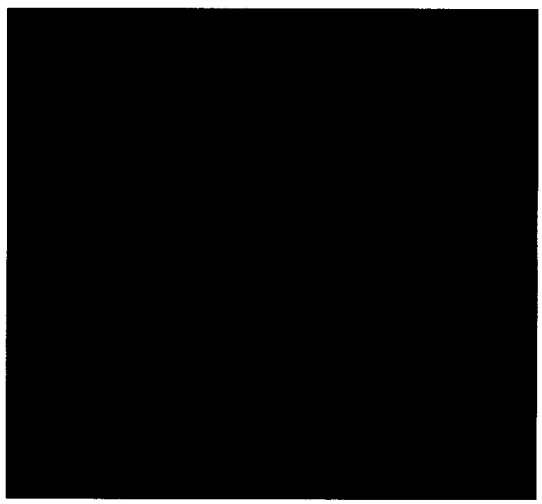
Using the SBIR awards, managed by NASA Langley Research Center (LaRC), Digiray enhanced the RGX system by modifying its x-ray tube to increase its penetrating capability from 100 kilovolts to 150 kilovolts and then, in the second award, proceeded to develop a portable x-ray system. In November 2001, a highly successful new test was performed on a Boeing 707 at an airfield in Melbourne, Florida using a dual robot. The detector array was mounted on one part of the robot and the x-ray source on the other. This is the first automated application for the RGX.

Digiray's patented reverse geometry laminography (RGL™) system is a result of the company's efforts to increase the x-ray energy of the RGX system. The RGL system provides layer-by-layer x-ray viewing with one x-ray exposure. The precision of Digiray's single exposure RGL system is demonstrated by its ability to provide separate head and tail coin images with one x-ray exposure. The resolution and gray scale performance of the laminography was recently improved according to Dr. Richard Albert, president of Digiray, by increasing the number of detectors from the eight used in the previous array to 64. The clarity of RGL may provide x-ray imaging for medical applications including mammography, cardiac imaging, brain surgery and orthopedics.

"Additionally, initial efforts are under way to develop x-ray diffraction," Albert said. "An operational prototype has been developed which gives complete texture determination with very high throughput." A patent was recently issued for this RGXRD™ system.

Commercialization of the RGX system is now in progress. Systems have been sold to Japan, the United Kingdom, Saudi Arabia, the US Air Force and LaRC, among others. In addition, said Albert, a motionless CT system is being tested for a medical or dental application in a joint program with the University of Southern California. ✿

For more information, contact Dr. Richard Albert at Digiray, Inc., ✉ *info@digiray.com*. Please mention you read about it in *Innovation*.



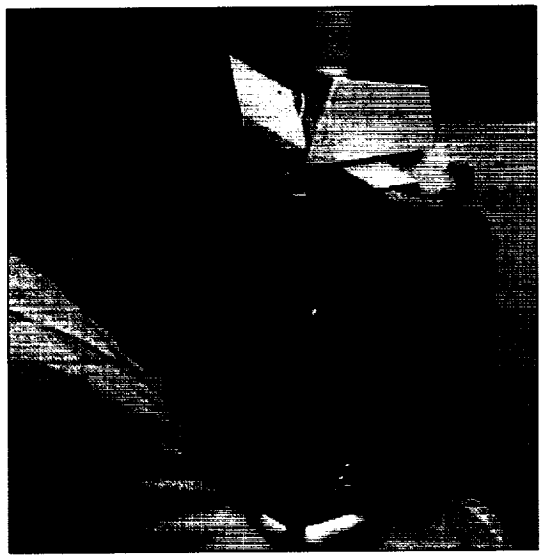
Reverse Geometry X-radiography improves image clarity to the extent that both the thin latex glove on the hand, as well as bone details can be seen. At right, teeth and jaw imaging benefit from high contrast resolution. Photos courtesy of Digiray, Inc.

Improving Digital Imaging

A COMPANY FOUNDED BY FORMER NASA engineers to research, develop and manufacture digital imaging technology has now evolved into an independent research and development organization. For 15 years, the business had supplied medical instruments for genetic diagnosis. Now named Advanced Digital Imaging Research (ADIR), the company specializes in digital-imaging software and algorithm development. ADIR is located in the Houston, Texas area, where it conducts R&D projects sponsored by the National Institutes of Health, NASA and other corporate clients.

Originally founded as Perceptive Systems, Inc. (PSI) in 1984 by Dr. Kenneth Castleman, a Jet Propulsion Laboratory digital-imaging expert, and Donald Winkler, a Johnson Space Center (JSC) image-processing expert, the company licensed a patent from JPL for the development of an automated system for chromosome analysis. It supplied advanced microscope-imaging systems used in the diagnosis of inherited diseases.

In 1995, the company was awarded a NASA Phase II SBIR contract to develop an automated microscope to examine the blood of returning astronauts for evidence of genetic damage due to radiation. The instrument could examine astronauts' blood cells and tabulate the amount of chromosome breakage that had occurred during space flight. This method is a more accurate assessment of radiation exposure than other means, such as film badges, and it permits crewmembers to have extended space flight careers without placing them at risk for cancer.



NASA image-processing techniques provide the foundation for the latest of chromosome analysis and genetic instrumentation. Photo courtesy of Jet Propulsion Laboratory.

At the moment, the company is successfully involved in researching medical imaging for a variety of applications in medical research and cancer diagnosis. The applications range from chromosome research in adults, newborns and prenatal babies to leukemia diagnosis systems that monitor the progression and regression of leukemia. ADIR productively performs image-processing algorithm design and software development for many corporate clients. ADIR staff members also serve on several US government and university advisory committees, and as adjunct faculty members. ADIR is a subsidiary of International Remote Imaging Systems, Inc. of Chatsworth, California. ✪

For more information, contact Dr. Kenneth R. Castleman, president of Advanced Digital Imaging Research, LLC, 2450 South Shore Blvd., Suite 305, League City, TX 77573, ✆ 281/535-1889, ✉ *info@adires.com*. Please mention you read about it in *Innovation*.

Analyzing Fluorescence May Improve Pharmaceuticals

A PORTABLE PHOTOSYNTHESIS ANALYZER developed to help determine if the ocean's plants are doing their part to reduce carbon dioxide in the atmosphere may soon be used in the quest to bring new pharmaceuticals to market.

The photosynthesis analyzer was developed by Ciencia, Inc., of East Hartford, Connecticut, in collaboration with the Stennis Space Center in Mississippi. The device measures the photochemical efficiency of phytoplankton in the oceans by detecting the fluorescence in the ocean water. Chlorophyll is the agent in plants that aids in the process of photosynthesis, the conversion of carbon dioxide and water into energy for plants.

According to Dr. Salvador M. Fernandez, president of Ciencia, the underlying technology of the photosynthesis analyzer is the ability to measure fluorescence

lifetimes. Fluorescence in plants occurs because the photosynthetic reaction is not 100 percent efficient; a small amount of the absorbed solar energy leaks as fluorescence. By measuring the fluorescence lifetime, it is possible to determine the efficiency of the photosynthetic reaction. "We have broadened the applications to other areas where it is useful to measure fluorescence lifetimes," Fernandez added.

"One application that is currently of interest to the scientific community is how cells transduce signals from the outside world into the nucleus," he said. "For example, to turn on a gene and have a response. This process is generically called cellular signal transduction."

There is interest in this particular application from pharmaceutical companies, Fernandez said. "Aside from the intrinsic scientific merit of understanding signal transduction, drug and biotechnology companies are interested in using this as a tool for drug discovery."

A drug typically works by binding to a receptor on the cell surface. This binding is what leads to signal transduction, he added. "Signal transduction involves protein interactions within the cell. Knowing which proteins interact with which other proteins during the signal transduction process is useful because understanding the process allows the development of drugs that enhance or interfere with the process. Fluorescence lifetime-based methods provide a powerful tool to study protein interactions in living cells." ✿

According to Dr. Salvador M. Fernandez, president of Ciencia, the underlying technology of the photosynthesis analyzer is the ability to measure fluorescence lifetimes.

For more information, visit *http://www.ciencia.com* or contact Kirk Sharp at Stennis Space Center, ✉ *kirk.sharp@ssc.nasa.gov*. Please mention you read about it in *Innovation*.

DATATURBINE OFFERS IMPROVED INFORMATION

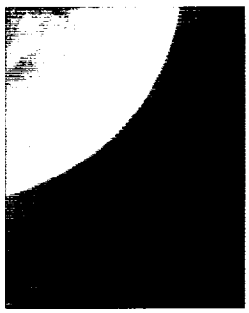
When lives and money are at stake, people have precious little time to sit and wait for computers to add value to the decisions that need to be made. But the ever-improving capabilities of computers, networks and the information-processing systems that they run make it possible to envision decision support systems that effectively improve the situational awareness and accelerate decision-making processes of groups and individuals. Eventually, independently focused applications get integrated and fused while time constraints and remote participants drive us toward decision support environments that are distributed and collaborative with high-performance or real-time characteristics.

It is for this type of environment that NASA has developed and commercialized the Ring Buffered Network Bus, or RBNB DataTurbine™. This Java middleware solution is a cost-effective network cache for high-performance hierarchical peer-to-peer computing and interactive application integration problems. An extension of publish-subscribe technology, it is particularly well-suited to network-based data acquisition and processing, requiring time-based access and correlation across diverse and geographically distributed nodes. Its role as an intermediary enables users to effortlessly and independently scroll back and forth through time on distributed data that may be continuously updated.

For the medical industry, RBNB is a useful tool for systems integrators and application developers. Application examples include adapting live telemedicine environments to enable video-on-demand or other sensor-history-on-demand capabilities, implementing temporary source-side measurement storage services for later transmission across intermittent links, and building new integration, fusion and data management capabilities into Web-based emergency operations infrastructure. ✿

For more information, contact Matthew Miller, manager, Scientific Data Products, Creare, Inc., ✉ *mjm@creare.com http://rbnbcreare.com*. Please mention you read about it in *Innovation*.

TECHNOLOGY OPPORTUNITY SHOWCASE



Technology Opportunity Showcase *highlights some unique technologies that NASA has developed and that we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in* Innovation

Breakthrough in Fourier Imaging Systems

Marshall Space Flight Center is seeking qualified companies to license and commercialize a breakthrough in Fourier Imaging Systems. NASA scientists have discovered a method for providing Fourier Imaging with as few as one or two grid pairs, while capturing the entire available spectrum.

The Rotational-Translational Fourier Imaging System has potential commercial applications in the following fields: medical imaging, offering finer resolution body scans and finding masses as small as 100 microns; telescopes, allowing for imaging of "high-energy events," such as solar flares or distant star activity, in greater detail than current telescopes; and defect analysis, finding flaws, stress cracks or other imperfections in metals or assembled metal components that x-rays might miss. Benefits of this breakthrough include reduced cost and increased quality. In the past, multiple grid pairs have been needed to create a Fourier telescope. It had been theorized that one or two grid pair telescopes were feasible, but no working prototypes had been developed, until now.

This technology has overcome the multiple grid pair hurdle, creating an imaging system that uses only two grid pairs. The first grid pair offers multiple real components of the Fourier-based image. The second grid pair provides multiple imaginary components of the Fourier-based image. With the reduction in grid pairs, the major cost of producing the multiple grid pairs has been lowered. Depending upon the application, the two grid pair production costs can be one-tenth of the price of a comparable 24-grid pair imager. While it would be expected that the quality of the invention's spectrum analysis would decline with the reduction in grid pairs, the opposite is actually the case. The Rotational-Translational Fourier Imaging System provides the ability to capture images across the entire available spectrum, rather than at discrete, predetermined intervals within the spectrum. Although the technology was developed for telescopes, its strength is in full-spectrum imaging of atomic particles and electromagnetic radiation. ✱

For more information, contact Dr. James Dowdy at Marshall Space Flight Center, ✆ 256/544-7604. Please mention you read about it in Innovation.

Optimized Image Compression (DCTune)

NASA Ames Research Center is seeking a qualified company to license and commercialize Optimized Image Compression (DCTune) technology. DCTune is computer software that significantly improves digital image compression.

NASA missions have and will continue to generate immense quantities of image data. NASA confronts a major technical challenge in managing this great flow of imagery in collection, preprocessing, transmitting to Earth, archiving and distribution to scientists at remote locations. Part of the solution to this problem lies in efficient image compression techniques. As part of a larger program of human factors research, NASA Ames Research Center has developed technology to improve image compression where the ultimate consumer is the human eye.

The DCTune quantization matrix is compatible with industry compression standards for digital image compression, including JPEG, MPEG and CCITT H.261. A second technique optimizes the Discrete Cosine Transform (DCT) quantization matrix for each individual image. This is accomplished by means of a model of visual sensitivity to compression artifacts. Together these two techniques allow systematic perceptual optimization of image compression in NASA imaging systems.

DCTune significantly improves compression efficiencies for pictures and videos. It can be an add-on software module for existing imaging workstation software or imaging devices, or hard wired into existing microchip designs.

DCTune offers three key benefits: control over desired picture quality/accurate specification of visual quality; optimum compression at given picture quality/reduced file size; and control over desired compression efficiency.

Potential commercial applications of DCTune include editing, storage and transmission of a variety of image data for use in digital copiers and scanners, digital facsimile machines, digital still cameras, digital video cameras and personal communications services.

In the DCTune technology, the sensitivity behavior of the human eye is accurately modeled, and it is able to precisely determine the amount of information needed for each image. DCTune calculates the best JPEG quantization matrices to achieve the maximum possible compression for a specified perceptual error.

To expedite transfer of this NASA technology to the commercial sector, the inventor has developed a prototype application and made it available to potential developers. DCTune1.1 is a minimal implementation of the DCTune technology. It is offered free for demonstration purposes only. ✱

For more information, contact David Lackner at NASA Ames Research Center, ✉ *dlackner@mail.arc.nasa.gov* or Patrick Hung at NASA Ames Research Center, ✆ 650/604-5063. Please mention you read about it in Innovation.

NASA Field Centers

Ames Research Center
Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

Carolina Blake
Ames Research Center
Moffett Field, California 94035-1000
650/604-1754
cblake@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Jenny Baer-Riedhart
Dryden Flight Research Center
Edwards, California 93523-0273
661/276-3689
jenny.baer-riedhart@mail.dfrc.nasa.gov

Glenn Research Center
Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High-Temperature Materials Research, Microgravity Science and Technology, and Instrumentation Control Systems.

Larry Viterna
Glenn Research Center
Cleveland, Ohio 44135
216/433-3484
Larry.A.Viterna@grc.nasa.gov

Goddard Space Flight Center
Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

George Alcorn
Goddard Space Flight Center
Greenbelt, Maryland 20771
301/286-5810
george.e.alcorn.1@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics and Autonomous Systems.

Merle McKenzie
Jet Propulsion Laboratory
Pasadena, California 91109
818/354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center
Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations.

Charlene Gilbert
Johnson Space Center
Houston, Texas 77058
281/483-0474
charlene.e.gilbert@jsc.nasa.gov

Kennedy Space Center
Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

Jim Aliberti
Kennedy Space Center
Kennedy Space Center,
Florida 32899
321/867-6224
jim.aliberti-1@kmail.ksc.nasa.gov

Langley Research Center
Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

Preston I. Carraway, III
Langley Research Center
Hampton, Virginia 23681-0001
757/864-6005
p.i.carraway@larc.nasa.gov

Marshall Space Flight Center
Selected technological strengths are Materials, Manufacturing, Non-Destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

Vernotto McMillan
Marshall Space Flight Center
Huntsville, Alabama 35812
256/544-2615
vernotto.mcmillan@msfc.nasa.gov

Stennis Space Center
Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Non-Intrusive Instrumentation.

Kirk Sharp
Stennis Space Center
Stennis Space Center, Mississippi
39529-6000
228/688-1914
kirk.sharp@ssc.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small start-up companies with significant business promise.

Bill Musgrave
Ames Technology Commercialization Center
San Jose, CA
408/557-6820

Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
440/260-3300

David Kershaw
Florida/NASA Business Incubation Center
Titusville, FL
321/267-5601

Bridget Smalley
University of Houston/NASA Technology Center
Houston, TX
713/743-9155

Joanne Randolph
Business Technology Development Center
Huntsville, AL
256/704-6000, ext. 202

Julie A. Holland
NASA Commercialization Center/California State Polytechnic University
Pomona, CA
909/869-4477

Martin Kaszubowski
Hampton Roads Technology Incubator
Hampton, VA
757/865-2140

Ann Lansinger
Emerging Technology Center NASA Business Incubator
Baltimore, MD
410/327-9150

Small Business Programs

Carl Ray
NASA Headquarters
Small Business Innovation Research Program (SBIR/STTR)
202/358-4652
cray@hq.nasa.gov

Paul Mexcur
Goddard Space Flight Center
Small Business Technology Transfer (SBIR/STTR)
301/286-8888
paul.mexcur@pop700.gsfc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D agencies and to foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

Ken Dozier
Far West Technology Transfer Center
University of Southern California
Los Angeles, CA 90007
213/743-2353

William Gasko
Center for Technology Commercialization
Westborough, MA 01581
508/870-0042

David Bridges
Economic Development Institute
Georgia Institute of Technology
Atlanta, GA 30332
404/894-6786

Gary F. Sera
Mid-Continent Technology Transfer Center
Texas A&M University
College Station, TX 77840
979/845-8762

Charlie Blankenship
Technology Commercialization Center, Inc.
Newport News, VA 23606
757/269-0025

Pierrette Woodford
Great Lakes Industrial Technology Center
Battelle Memorial Institute
Cleveland, OH 44070
440/734-0094

Joseph P. Allen
National Technology Transfer Center
Wheeling Jesuit University
Wheeling, WV 26003
800/678-6882

Dan Winfield
Research Triangle Institute Technology Applications Team
Research Triangle Park, NC 27709
919/541-6431

NASA ONLINE

Go to the **NASA Commercial Technology Network (NCTN)** on the World Wide Web at ***http://nctn.hq.nasa.gov*** to search NASA technology resources, find commercialization opportunities and learn about NASA's national network of programs, organizations and services dedicated to technology transfer and commercialization.

Events

On March 6 and 7, NASA's Jet Propulsion Laboratory in Pasadena, California will host the ***14th Annual High-Tech Conference for Small Business*** at the Westin Los Angeles Airport Hotel. The two-day conference will focus on subcontracting and marketing opportunities for small, minority, women-owned and veteran-owned businesses in high-tech industries. A registration fee of $100 per person is due no later than February 18, 2002. Pre-registration is advised, as this event is well attended. To obtain a registration form, please visit the conference Web site at *http://acquisition.jpl.nasa.gov/boo/*. For further details, send an e-mail to *Andrea.R.Salazar@jpl.nasa.gov* or call 818/393-5963. For hotel accommodations, contact the Westin at 310/216-5858.

In conjunction with the High-Tech Conference for Small Business, JPL will hold the ***7th Annual NASA/JPL Space Science Symposium*** on March 5. The symposium is an interactive and informative session highlighting the agency's space science and Earth science programs to potential high-tech, small business suppliers. This event is free, and pre-registration is highly recommended, as space is limited. To pre-register, please e-mail *maryhelen.ruiz@jpl.nasa.gov* by February 28.

Strategies and Models for Improving Safety and Quality will be held March 4–5, 2002 in Cape Canaveral, Florida. This conference has been facilitated to promote direct interaction and to openly discuss high-visibility topics affecting the quality of products and services. The conference will allow individuals to learn and benchmark from the successes of some of the industry's leading companies and organizations. Government and industry leaders, such as NASA's Johnson Space Center, will give presentations. For more information or to register, go to *http://www.asdnet.org*

Reminder: The ***2002 IEEE Conference*** will be held March 9–16, 2002. Top areas will include aerospace systems, their underlying science and technology, and their applications to government and commercial endeavors. Additional information can be obtained at *http://www.aeroconf.org*

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